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CITATION:

Handa, Hajime ...[et al]. EXPERIENCES WITH B.E.S. (BALANCED ELECTROLYTE SOLUTIONE). 日本外科宝函 1953, 22(5): 542-545

ISSUE DATE:

1953-09-01

URL:

http://hdl.handle.net/2433/206020

症 例 報 告

EXPERIENCES WITH B. E. S. (BALANCED ELECTROLYTE SOLUTIONE)

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[Received for Publication June 25]

During the past few years it has become recognized that the proper use of water and electrolyte solutions is of essential importance in surgical patients. In foreign countries, especially in the United States, various kinds of electrolyte solutions have been widely used in order to maintain the normal levels of electrolytes and water in plasma and tissue cells. In this country, however, such electrolyte solutions other than 0.9% sodium chloride solution and Ringer's solution have not yet generally come into use.

In this report, laboratory data in our clinic will be presented, regarding the comparison of effects of B. E. S. and other solutions commonly used for infusion. B. E. S. is a new electrolyte solution, reported by C. L. Fox and his co-workers in 1951. The characteristic of this solution is that potassium and bicarbonate precursors are present twice in amount, while sodium, chloride and magnesium in the same proportion as found in normal human plasma. The composion of B. E. S. is compared in Table 1 with normal human plasma, and other common infusion solutions. Approximating formula for preparation of B. E. S. are shown in Table 2.

Table 1. -- Comparison of B. E. S., Plasma and Other Solutions. Concentrations are given in mEq. per liter.

	Normal Plasma	B.E.S.	0.9% NaCl	Ringer	Darrow
Na	140	140	154	147	122
Cl	103	103	154	157	104
HCO_3	27	55*	0	0	53**
K	5	10	0	4	35
Ca	5	5	0	6	0
Mg	3	3	0	0	0

HCO_3 yielded by metabolism of acetate* or lactate**

Table 2. -- Approximate formula for preparation of B. E. S.,

	mEp. in B. E. S.	Molec. Wt.	Grams per liter to be used
NaCl	103	58.5	6.03
K Acetate	10	98	0.98
Na Acetate	37	82	3.03
Ca Citrate	5	570*	0.475
Mg Citrate	3	703**	0.585

* $Ca_3(C_6H_5O_7)_2 \cdot 4\,H_2O$ divide by 6 for millieq. uivalents :

$$\frac{570}{6} \times 5 = 475 \text{ mg.}$$

** $Mg_3(C_6H_5O_7)_2 \cdot 14\,H_2O$ divide by 6for millieq. uivalents :

$$\frac{703}{6} \times 5 = 585 \text{ mg.}$$

ADVANTAGES OF B. E. S.

C. L. Fox and his co-workers have shown that during the first forty hours after operation, large amounts of potassium are excreted in the urine from traumatized muscles, and in addition, since the taumatized muscles acquire sodium, chloride and water, the postoperative potassium defiicit and retention of salt would appear to result largely from the excretion resp. deposition of thes ions and water. Furthermore, they have ascertained that the more extensive the operative procedure and the greater the degree of local traumatization, the greater would also appear the unbalance of these ions, and that the use of B. E. S., instead of 0.9% saline solution, in surgical patints, would result in the rapid renal excretion of water, sodium and chloride, and maintain essentially normal levels of potassium and bicarbonate in plasma and of extracellular ions, i. e. sodium and chloride. Thus, C. L. Fox and his co-workers have contended that B. E. S. is a much better electrolyte solution than 0.9% saline solution or Ringer's solution.

In addition, we are interested in that magnesium ion is also present in B. E. S. in the concentration similar to that of normal plasma, because as to the effects of various kinds of electrolytes on the metabolism of the nervous systeme it has been generally accepted that sodium ion controls both aerobic and anaerobic glycolysis in nerve cells, while magnesium and potassium ions accelerate such glycolysis, thus subserving to prevent disturbances of neuromuscular functions.

On the theoretical grounds above mentioned, B. E. S. has been used in our clinic since September 1952, instead of 0.9% saline solution and Ringer's solution for infusions as well as for washing of the exposed brain during the intra cranial operation.

RESULTS

In an effort to determine whether this solution offers any actual advantages, 19 patients were selected, in 11 of which B. E. S. and in 8 0.9% saline solution was administered respectively and the changes in the plasma patassium and chloride levels were measured before and after 24 hours and the seventh day following operation. In some other patients, especially after gastrectomy, the electrocardiographic changes were concomitantly observed on the third to fifth day postoperatively. As shown in Table 3, most patients received 200—400 cc. of blood and 1000—1500 cc. of either B. E. S. or 0.9% saline solution at the time of operation. Then on each succeeding postoperative day, usually 500 cc. of either B. E. S. or 0.9% saline solution and 50—100 cc. of 20% glucose were given until fluid intake wholely by mouth became tolerated. No other intravenous solutions were used.

The individual cases are shown in Table 3 and several remarks will be made :

1. Within 24 hours after operation, out of 11 cases receiving B. E. S. only 2 showed a decrease in the concentration of potassium in plasma. In contrast, in 6 cases out of 8 receiving 0.9% saline solution, more or less decrease in the concentration of potassium in plasma was demonstrated.

2. Any significant change in the concentration of chloride in plasma could

Table 3. -- Changes in the plasma potassium and chloride levels. Concentrations are given in mEq. liter.

(1) Patients administered B. E. S.

Operation	Age	sex	Intake during the operation	K			CI		
				Before op.	Postop. days 1	7	Before op.	Postop. days 1	7
Gastrectomy	51	M.	200 Bl. 1000 B. E. S.	4.4	4.7	4.3	98	89	97
	53	M.	300 Bl. 1000 B. E. S.	4.2	4.6	4.7	106	99	99
	50	F.	200 Bl. 1000 B. E. S.	4.5	5.3	4.7	109	107	109
	27	F.	300 Bl. 1000 B. E. S.	5.1	5.1	5.2	106.5	100.5	101.5
	30	F.	200 Bl. 1000 B. E. S.	4.5	5.0	4.7	104.5	104	104.5
Colon resection	61	F.	300 Bl. 1000 B. E. S.	5.2	5.9	5.2	107.5	108.5	99.5
Cholecystectomy	66	M.	400 Bl. 1000 B. E. S.	4.0	5.1	3.7	92	86	90
Craniotomy	22	M.	200 Bl. 1000 B. E. S.	4.9	5.1	5.2	110.5	104.5	104
	14	F.	200 Bl. 1500 B. E. S.	4.3	5.2	4.5	108	112	
Extirpation of sarcoma of head	55	M.	300 Bl. 1000 B. E. S.	4.6	3.7*	5.2	110.5	103.5	98.0
Laparotomy (sarcoma)	15	M.	200 Bl. 1000 B. E. S.	4.0	3.9*	3.5	94.0	97.0	104.5

(2) Patients administered 0.9% saline solution

Craniotomy	34	M.	400 Bl. 1000 NaCl	4.4	3.7	4.3	90	98	104
	13	F.	200 Bl. 1000 NaCl	5.3	4.1	3.4	108.5	103.5	104
	50	M.	200 Bl. 1000 NaCl	5.7	4.8		111.0	104.0	107.5
	27	F.	400 Bl. 1000 NaCl	3.6	4.7*	3.4	102.5	101.5	103.5
	18	M.	200 Bl. 1000 NaCl	4.7	3.9	4.4	103.0	101.5	94
Gastrectomy	54	M.	200 Bl. 1000 NaCl	4.4	4.0	4.3		100	98
Cholecystectomy	57	M.	200 Bl. 1000 NaCl.	4.5	3.9	5.2	110.5	106.5	98
Extirpation of rectal cancer	43	M.	800 Bl. 1000 NaCl	4.7	4.9*	3.8	96.5	101.0	94

not be found.

3. Electrocardiographic findings : When 0.9% saline solution was administered in the cases of gastrectomy, most of them tended to show the following electrocardiographic changes accompanying the low concentrations of potassium in

plasma on the the third to fifth day postoperatively : (1) slightly prolonged Q-T interval, (2) decreased height and inversion of the T waves, (3) rounded and prolonged T waves and (4) depression of the S-T segments. These changes could not be found in the cases rece.v ng B. E. S..

DISCUSSION

The results obtained seem to indicate that following the use of B. E. S. there occurs less variability of plasma potassium and chloride levels, as compared with 0.9% saline solution. However, it should be noted that in none of these patients, even in those indicating a marked decrease, did the plasma potassium level fall below 3.5 mEq. per liter or into such a low range that hypopotassemia or the symptoms associated with it might be expected to occur. This seems to be due (1) to the use of B. E. S. or 0.9% saline solution in a relatively small amou t, and (2) to the incomplete washing of the stmach before gastrectomy. It seems that the larger amount of infusion solution be administered, the greater would be the changes in the plasma potassium and chloride levels.

Moreover, in the metabolism of potassium, it is to be noticed that low plasma potassium is not always demonstrable in the potassium deficiency of the entire body, because potassium exists largely within the cells. However, according to Hewitt and his co-workers, 94 mEq. of potassium was lost in five postoperative day totals and correspondingly the decrease in the plasma potassium level was found to be more than 1 mEq. per liter. Therefore the measurement of plasma potassium seems to be useful for the estimation of the metabolism of potassium, at least for the comparison of daily changes in its metabolism.

SUMMARY

B. E. S. has been used in our clinic since September 1952, instead of 0.9% saline and Ringer's solution. Judging from the changes in the plasma potassium and chloride levels, and in the electrocardiograms before and after operation, B. E. S. appears to be a better electrolyte solution than 0.9% saline solution or Ringer's solution.

Reference

1. C.L. Fox, J. M. Winfield, L. B. Slobody, C.M. Swindler and J. K. Lattimer: Electrolyte solution approximating plasma concentrations with increased potassium for routine fluid and electrolyte replacement. J. A. M. A., **148**, 827-833, 1952. 2. J. M. Winfield, C. L. Fox and W. L. Mersheimer: Etiologic factors in postoperative salt retention and its prevention. Ann. Surg., **135**, 626-640, 1951. 3. D. C. Darrow and E. L. Pratt: Fluid thrapy : Relation to tissue composition and the expenditure of water and electrolyte. J. A. M. A., **143**, 432-439, 1950. 4. J. Miyake: Studies on the metabolic exchange of electrolytes, sodium, chloride and potassium in the surgical patients. Nihon Geka Gakkai Zasshi, **53**, 990-996, 1953. (in Japanese)

和文抄録 B.E.S. (Balanced Electrolyte Solutoin) の使用經驗

B.E.S. はC.L. Fox等により作られた一種の輸液でその溶液中にK^+, HCO_3^- 濃度は正常血漿の倍量，其の他の Na^+, Cl^-, Ca^{++}, Mg^{++} 濃度は正常血漿と等量含まれている．京大外科第一講座では1952年9月からRingen氏液，生理的食塩水の代りに点滴注射の場合は勿論，脳手術の際の洗滌等にも原則としてすべてB.E.S.を用いている．B.E.S.を用いた場合と，生理的食塩水を用いた場合に於て，術前，術後の血清中のK, Clの変動，心電図の変化を検討した結果，B.E.S.を用いた場合の方が生理的食塩水を用いた場合よりも確かに優秀な事を認めた．